Boulder Community Foothills Hospital is a new women and children's center located on a 49-acre site in Boulder, Colorado. The 154,000-square-foot, 60-bed hospital, complimented by a 67,000-square-foot outpatient services building, provides comprehensive OB/GYN and pediatrics services and features private NICU/family suites. Other services include imaging, surgery, lab and emergency care. Master planned for 400,000 square feet, the campus will eventually occupy 17 acres of the site. The remaining 32 acres have been dedicated to the City as permanent open space. The facility is the first LEED™ certified hospital in the United States.

Boulder Community Foothills Hospital

Labor and Delivery 9 Suites
Mom/Baby Unit 16 Private Rooms
Special Care/NICU 6 Suites
Med/Surg Units 16 Private Rooms
Conference Center
Pediatric Unit 8 Private Rooms
Imaging
Surgery 4 Operating Rooms
Laboratory
Clinical Space
Pharmacy
Emergency Department
Resource Center
Cafe
Physician Office Space

Building Location:
4747 Arapahoe Avenue
Boulder, Colorado 80303

Project Type:
New Construction

Construction Cost:
$56 million

Square Footage:
154,000

Project Complete:
September 2003

Owner:
Boulder Community Hospital

Architects:
OZ Architecture/Boulder Associates, Inc.

Landscape/Site Planning:
Civitas

Interior Design:
OZ Architecture/Boulder Associates, Inc./
SO Design

Civil Engineer:
Drexel Barrell

Structural Engineer:
Monroe Newell

Mechanical Engineer:
Shaffer/Baucom

Electrical Engineer:
BCER

Medical Equipment/Communications Planning:
Gene Burton & Associates

Medical Equipment Coordination/Installation:
Integrated Industrial Technologies

Food Service and Laundry Planning:
Thomas Ricca Associates

LEED™ Consultants:
Architectural Energy Corporation

Contractor:
Gerald H. Phipps, Inc.

Commissioning:
Farnsworth Group

Daylighting, a benefit to both patients and staff, is controlled with roller shades.

Unique Design Elements

Boulder Community Foothills Hospital is designed to maximize patient comfort. Private rooms offer patients control over all aspects of their environment including room temperature, lighting, daylighting levels, privacy and views. All patients have the option for a guest to stay comfortably in their room overnight. Parents of infants in neo-natal intensive care are offered adjoining rooms, where they can be next to their children and participate in their care until the infant is ready to go home. These and other provisions for a healthy and comfortable family-centered setting are expected to improve patient outcomes, reduce stays, and help to optimize use of the building.

The use of environmentally responsible materials was a high priority. The materials for the concrete building frame, face brick and sandstone were all harvested and manufactured locally, and installed by local subcontractors. The building also contains a very high percentage of recycled content materials. Sixty-four percent of all job-site construction waste was recycled. Designated collection rooms within the building will continue to help keep recyclable materials out of the landfill.

Unique Design Elements (Cont.)

Capital investment in a central utility plant is rare for a project of this size. Plans for future build-out of the site and energy efficiency concerns drove the decision to install the plant in Phase I, rather than in a later phase. Analysis of the $1.3 million investment showed a payback period of 12 years. Selected boilers and chillers have high efficiencies at all load conditions, providing a significant reduction in CO_2 production. Boilers are equipped with low NOx 30 PPM burners, exceeding requirements of present Colorado law. This NOx level is 70 percent lower than standard boiler burner equipment.

The local climate averages more then 4000 hours annually where low dry bulb and wet bulb conditions allow an airside economizer cycle, effectively providing "free cooling". A waterside economizer, or flat plate heat exchanger, also takes advantage of the local climatic wet bulb conditions.

Selected boilers and chillers have high efficiencies at all load conditions, providing a significant reduction in CO_2 production.

This further reduces CO_2 production and chiller run time, translating to reduced chemical water treatment and water consumption at the cooling towers.

Variable speed pumping was used throughout for chilled water, condenser water, boiler feedwater and building heating hot water systems. Variable frequency drives were also used for building supply and return air fans, as well as for the cooling tower fans. These devices provide demand-driven energy consumption.

With the extensive use of VFDs, energy consumed is equal to the required load, whereas traditional systems would consume the same fan or pump energy regardless of the demand.

Code-required operable patient room windows presented a special challenge to the design team. In order to maintain air pressures and energy efficiency, the operable windows were interlocked to the mechanical system. The interlocks automatically turn off the VAV boxes when the windows are opened. The DDC system automatically notifies the plant manager if numerous open windows are causing the system to run inefficiently.

Xeriscaping is a term copyrighted by the Denver Water Department and is derived from a combination of the word "landscape" and the Greek word "xeros" which means "dry". It is used to describe a water conserving landscape, and its principles have been incorporated into the Boulder Community Foothills Hospital campus. Many of the plantings are either native to Colorado or to another part of the world with a similar climate. The landscape design for the campus is expected to save 40 percent over typical Colorado irrigation water usage. Disturbance of wetlands present on the site was avoided wherever possible. The small area that was disturbed was reconstructed six-fold in an appropriate location elsewhere on the site, where it will not be disturbed again.

Purple Silvermound Sage [artemsia schmidtiana] does more than decorate the Boulder Community Foothills Hospital site. Xeriscaping with native or other similar plans is expected to save over 40 percent over typical irrigation water usage.

Goals and Objectives

The project team for Boulder Community Foothills Hospital sought to achieve the following goals and objectives, effectively reducing the hospital's impact on the environment:

- Maintain site biodiversity.
- Minimize the building footprint and reduce stormwater run-off.
- Encourage alternative transportation.
- Reduce water usage.
- Optimize energy performance.
- Ensure good indoor air quality.
- Reduce waste, resource depletion and embodied energy.
- Ensure actualization of design intent.

Strategies Employed

Protected during construction, existing plants and animals now contribute to biodiveristy surrounding the hospital.

- The site has historically housed a sizeable prairie dog colony; an animal on which many other species are dependent. The colony was relocated away from the construction zone. The animals were separated from the hospital by a specially constructed double fence designed to keep the animals in the 32 acres of dedicated open space and out of direct contact with humans. Studies showed no evidence of endangered species on the site. Existing plant and animal habitat in the dedicated open space was protected during construction and will be maintained in perpetuity. Disturbed wetlands were replaced six-fold.

- Minimize the building footprint and stormwater run-off:

The building footprint was minimized by designing efficient circulation routes and by maximizing the number of stories wherever the program allowed. The small one-story portion was structured for future vertical expansion. Nominal parking and grass paver fire lanes further minimize stormwater run-off.

- Encourage alternative transportation:

The project is located along several bus routes, and two new bus stops were provided for employees, patients, and visitors. Signed carpool spaces encourage employees to share a ride, and bike racks, showers and changing facilities encourage employees to bike or walk to work. The site is linked to an existing City of Boulder bike path located along Boulder Creek. Paved parking surfaces were reduced appropriately to 25 percent below City requirements via a deferred parking waiver.

In addition to environmentally sound, the Boulder Community Foothills Hospital is also a healing environment. The pediatric area features a camp-theme with this central sun and moon display.

- Reduce water usage:

In addition to low water-use plantings, the project incorporates waterless urinals and electric eye faucets in public toilet rooms, and low flow faucets in clinical areas.

- Optimize energy performance:

The central utility plant houses equipment that is significantly more energy efficient and less expensive to maintain than that required for a decentralized system. Patient rooms are individually controlled and windows are interlocked with the VAV system. Other energy-efficient features include white Energy Star™ roofs, mansard overhangs, trellises, daylighting, low-E glazing, revolving doors, roller shades, T5 lamping, daylight sensors and occupancy sensors. Many spaces offer multiple lighting levels, and zoning of the mechanical system allows for localized control. Direct gas fired dryers ensure that all energy produced by the burnt fuel goes directly into drying clothes. The hospital further plans to purchase renewable energy.

Roller shades in public areas temper the Colorado sun.

Efforts to protect indoor air quality included the use of low - VOC products, a two-week building flush and tight control of construction debris.

◆ Ensure good indoor air quality:

Low-VOC and formaldehyde-free products were teamed with a construction air quality management plan and two-week building flush-out period, to provide enhanced indoor air quality for all who use this non-smoking facility. Over 90 percent of partitions are full height, minimizing distribution of contaminants. Insulated partial height partitions were capped or coated to keep insulation particles contained. Walk-off mats are provided at all major entrances. A minimum of 95 percent air filtration was provided throughout. CO^2 demand ventilation control maintains CO^2 at acceptable levels in the building. All intakes are remote from any vehicular traffic and optimized to mitigate re-circulation of contaminants. Positive building pressurization is used to eliminate infiltration. The air diffusion performance index was applied for maximum air mixing within occupied spaces. Central station double-wall air handlers with walk-in access promote routine disinfection of the cooling coil drain pan and other interior surfaces. Materials and ducts were protected from contamination during the construction process. SMACNA IAQ Guidelines for Occupied Buildings Under Construction, 1995, and AHSRAE 52.2-1999 were followed.

Waste reducing strategies:

- Materials with recycled content
- Controlled construction waste
- Continued recycling on campus

◆ Reduce waste, resource depletion and embodied energy:
Strategies included use of locally harvested and locally manufactured materials, materials with recycled content, construction waste management, and provision for continued recycling efforts on the campus. A further strategy was to provide for long equipment service life. Centralized equipment is constructed to last for more than 25 years. Piping, insulation and ductwork materials are suitable for 50 years of service. All mechanical equipment can be readily serviced and maintained via full size stairways, encouraging improved and repeatable maintenance which in turn increases useable life.

◆ Ensure actualization of design intent:
The building was fully commissioned by a third party commissioning agent.

Optimize more than one component

The design of Boulder Community Foothills Hospital was an integrated team effort. Architects, urban planners, landscape architects, mechanical engineers, electrical engineers, energy consultants, facilities staff, administrators, and contractors were brought together weekly during the design process to suggest and review options and to make decisions as a team. User group representatives were assigned to assist with the design of each department, and neighborhood meetings and patient focus groups brought community input to the table. During this process interrelationships between systems and strategies were identified that worked together to improve the overall design.

Wayfinding and daylighting in public spaces were two elements that found common ground early on. Many large institutions suffer from poor circulation, compounded by years of additions and relocations within the building. A short circulation spine that provides waiting areas and access to each of the departments was developed to be the permanent major circulation vehicle within the hospital. It connects the hospital to the outpatient services building and is planned to extend with the addition of any future service lines or additional medical office space. Located on the western side of the building and wrapping three sides of an open-ended courtyard, this element provides continuous views of the nearby foothills. A secondary circulation path connecting the front lobby to the emer-

Shaded entries, dining areas and walkways welcome staff, many of whom arrive on foot, bike or via public transportation.

gency department is located along a glazed walkway that faces the main parking lot and major arterial. Views to familiar landmarks allow local residents to easily orient themselves.

Mansard overhangs were originally conceived to enhance the aesthetics of the building. Further study optimized their size and opacity, allowing them to fully shade the third-story windows from the summer sun. When cost implications required a reduction of the mansards, those located on the south and west sides were retained. These two facades benefit most from solar shading and are also the most visible from major view angles.

Encouraging alternative transportation and reducing storm water run-off worked hand-in-hand. Accessibility to bus service, carpooling spaces and bike racks enabled a reduction in the number of parking spaces to 25 percent below the City requirement. This, in turn, reduced the amount of impermeable surface on the site, which reduced stormwater run-off by 25 percent in the parking areas. Additionally, grass pavers were used to construct the fire lane. In one area the fire lane is incorporated with the pedestrian walks in the courtyard, eliminating duplication of surfaces.

Concrete was chosen for the structure of the building for several reasons. The materials are locally harvested and local companies employ qualified labor. Concrete can be provided with less lead time than steel and the forms are re-useable. Vibration control is vital in surgery and imaging departments, and is more easily achievable with concrete. The height restrictions placed on the site by the City required a minimal floor-to-floor height be used if the number of stories was to be maximized. Taking these factors into account, concrete flat plate construction was selected for the structural frame.

Lastly, energy and water saving features combined to reduce resource depletion. An enhanced thermal envelope moderates heating and cooling loads, which in turn lessens the required size of the HVAC equipment. Smaller equipment minimizes the natural resources necessary for manufacture. Low flow plumbing fixtures reduce the necessary piping sizes, which in turn diminishes the need for natural resources such as copper.

Qualitative and quantitative results

- BCFH uses 35 percent less energy than the ASHRE compliant baseline.
- Direct gas-fired dryers are 20 percent more efficient than steam dryers
- High-efficiency partial load low NOx boilers reduce NOx emissions by 70 percent

Energy savings were determined utilizing DOE-2 software. The building was compared to a theoretical structure that minimally meets HRAE/IESNA Standard 90.1-1999, and was determined to use 35 percent less energy than the ASHRAE compliant baseline.

Variable speed chillers will save 25 percent in annual chiller operating costs over constant speed chillers. Energy efficient variable speed pumps will provide a payback period of less then 2 years. Direct gas fired dryers are 20 percent more efficient than steam dryers.

Demand ventilation combined with an outside air economizer optimizes the maximum outdoor air capability while minimizing energy consumption. This provides more hours of increased ventilation with greater occupant comfort, without suffering an energy penalty. Selection of air devices with a high ADPI (air diffusion performance index) also improves occupant comfort.

High-efficiency partial load low-NOx boilers reduce annual NOx emissions by 70 percent, CO by 50 percent, and energy fuel consumption by 20 percent over standard boilers. Variable supply and return fan controls reduce CO2 emissions by 5.5 million lbs/year, SO2 by 8.3 million gm/year and NOx by 8.1 million gm/year. They provide a payback period of less then 1 year.

Variable speed supply and return fan controls reduce the sound levels at all times of day, during all seasons.

All occupied spaces have sufficient plumbing, medical gas and HVAC to meet continuing changes in healthcare requirements. The central plant is designed to provide long-term growth without increasing in size or having to duplicate distribution. Valves and dampers were placed to easily isolate areas for remodeling or repair. Minimizing replacement and/or restructuring of systems reduces operations and maintenance costs as well as disruption of service, downtime, and resource depletion.

Calculated for materials categorized in division 3-10 by the Construction Specifications Institute, the entire building contains a minimum aggregate weighted average of 10 percent post-consumer or 20 percent post-industrial recycled content material.

Careful documentation of construction waste removal on the site revealed that 64 percent of all jobsite construction waste was recycled, and designated collection rooms within the facility will continue to help keep recyclable materials out of landfills.

Analysis also showed that water consumption for irrigation was reduced by over 40 percent as compared to a typical design. Savings will be realized after two years, when plantings have had a chance to establish.

The entire construction and design team worked to ensure that the majority of construction waste, 64 percent, was kept out of landfills.

Obstacles / Benefits

- Obstacles:

Several obstacles were encountered during the design process which kept the team from more fully achieving their goals.

One of these obstacles was the owner's non-profit status. Attempts to incorporate photovoltaic panels on the project were derailed due to the inability to show any reasonable timeframe for payback on the system. Had a tax credit been available to offset the costs of the system (as are available to for-profit organizations), the payback period would have been significantly reduced. Low energy costs in Colorado also affected the decision-making on this issue.

One obstacle to sustainability was upfront cost. Surface parking was selected over structured parking, which would have been more expensive but reduced stormwater run-off.

Water rights issues severely impacted the ability to reuse water on the site. In Colorado, water rights are based on the doctrine of prior appropriation. Under this doctrine a property owner does not own water that rains, snows or flows across or adjacent to their property. Among other things, it is therefore illegal to harvest rainwater or use gray water for above-ground sprinkler systems. A special permit and/or water courts decree may be necessary in order to legally use these types of water for subsurface systems, which can significantly reduce evaporation of water slated for another purpose downstream.

Another obstacle was upfront costs. The payback period and space required for ice storage made this type of system impractical. Solar hot water was studied and proven to be feasible for this project, however costs for providing this system and upgrading the structure to support it caused it to be ruled out. Surface parking was provided in lieu of structured parking due to financial impact. Structured parking would have significantly reduced stormwater run-off from the site.

- Benefits:

The owner and the project team have led by example with this project, and are encouraging others to build more sustainably. Marketing efforts have raised the awareness of the local community, and the project is becoming a benchmark for many regional hospitals.

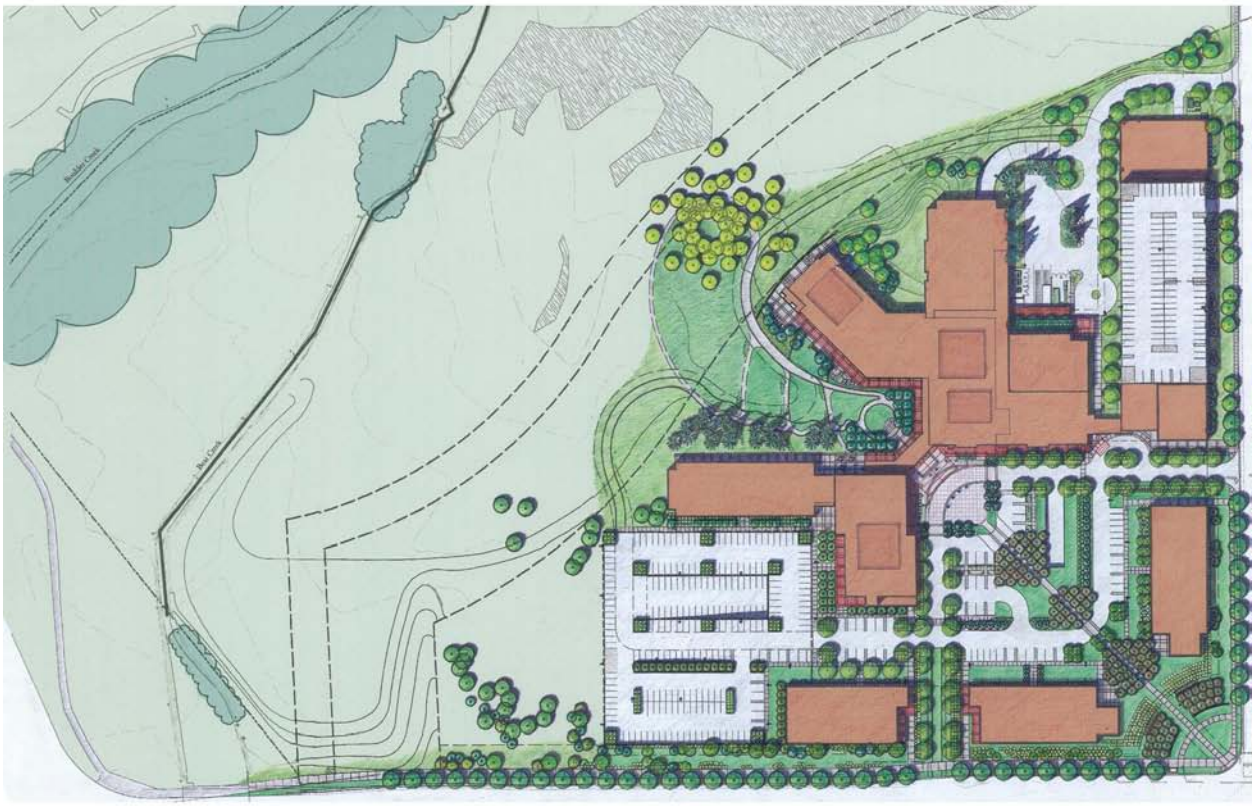
The new hospital will provide a healthier space for patients, visitors, and staff. Attributes provided by sustainable design efforts such as daylighting and good indoor air quality should help to attract nursing staff during the current nationwide nursing shortage, and may reduce absenteeism.

The facility will be easier to maintain, remodel and expand. Service interruptions for repair, replacement or expansion should be reduced. Energy and water bills have been minimized, freeing up more capital for other uses.

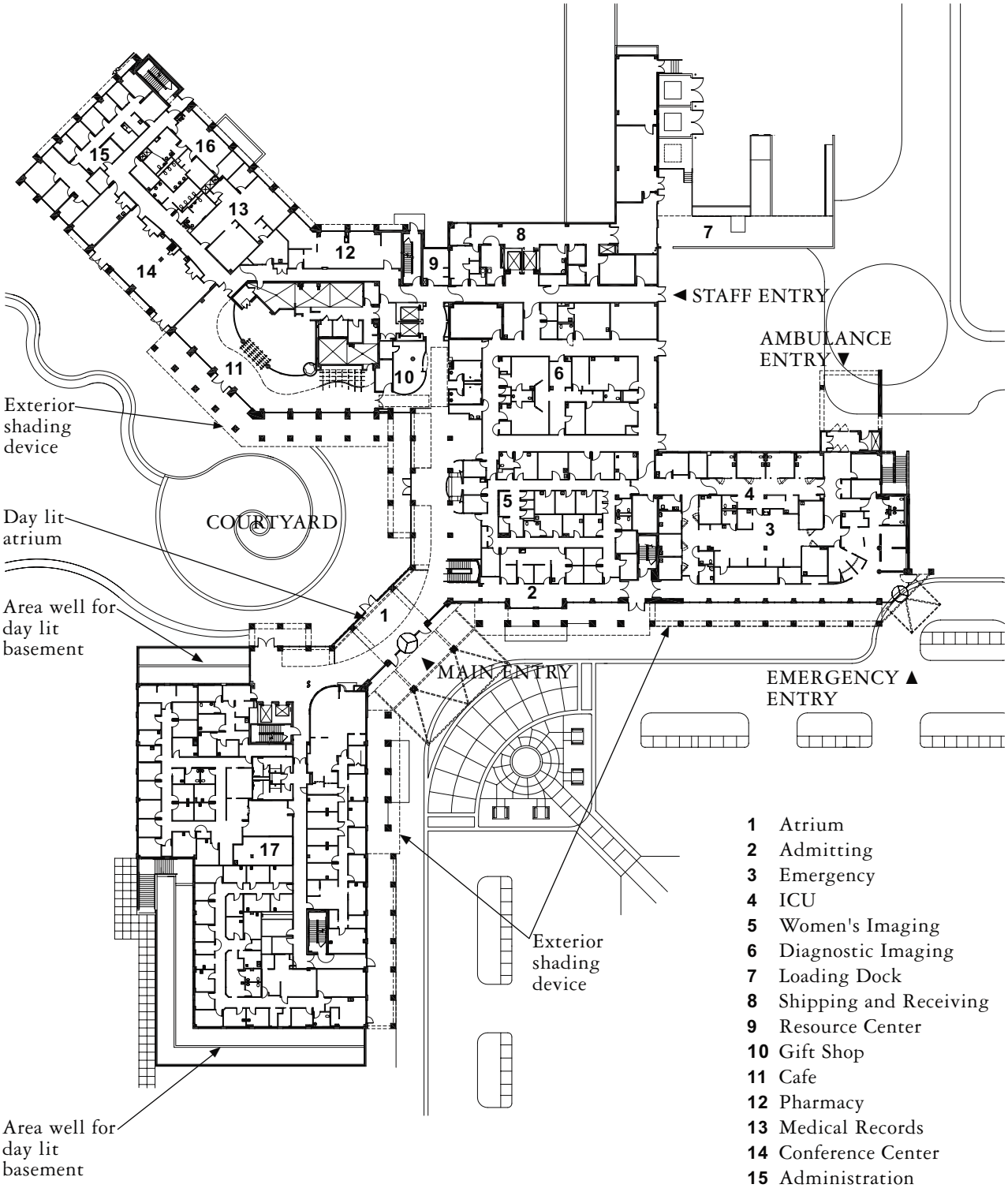
Finally, Boulder Community Hospital is known as a good corporate citizen, and this project stands to raise their social capital within the community, proving this sustainable building significantly reduces our impact on the environment and on future generations.

Boulder Community Foothills Hospital will provide a warm, sustainable welcome to the next generation of Boulder County residents.

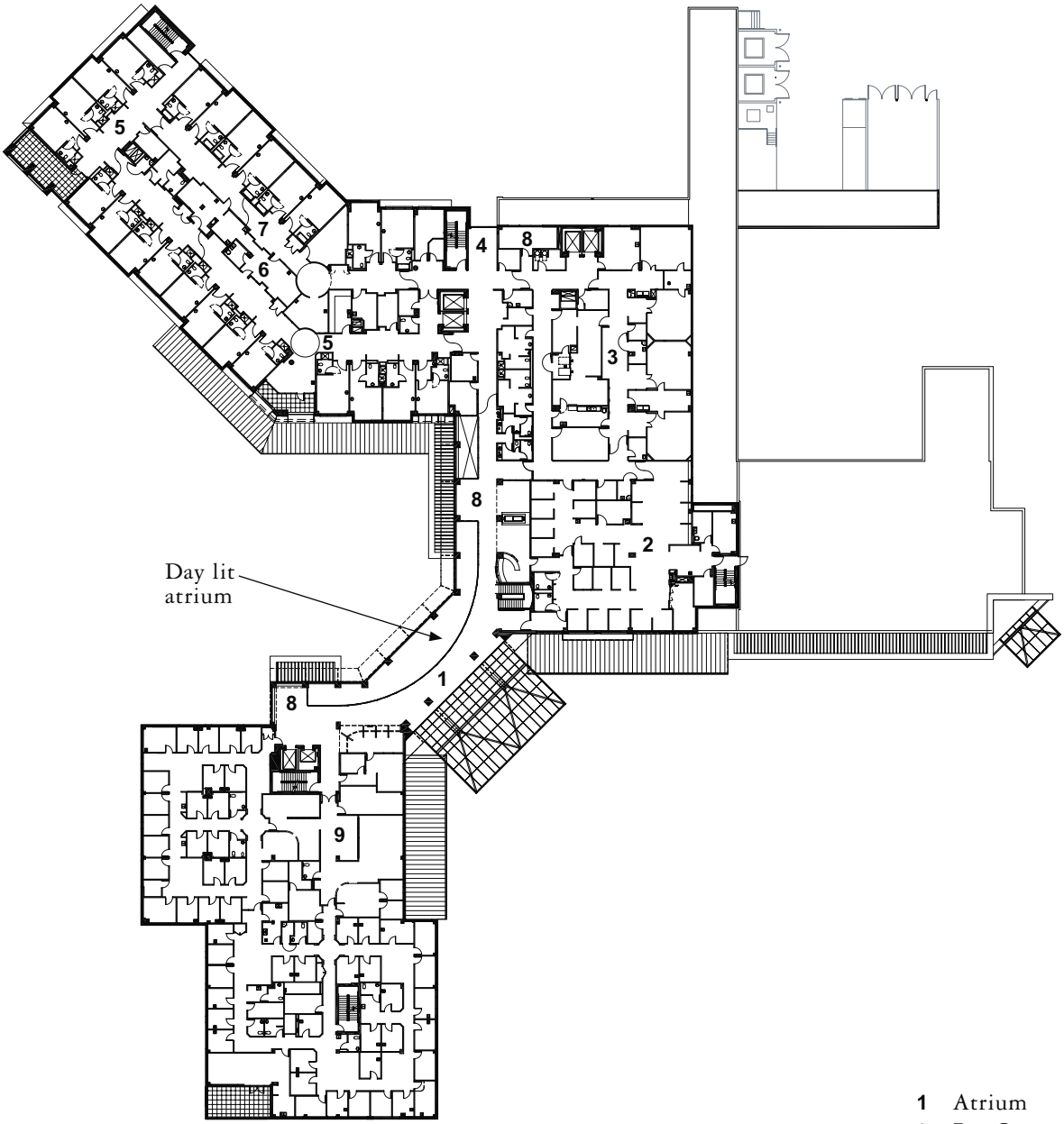
CURRENT SITE PLAN



MASTERPLAN


STAFF ENTRY
AMBULANCE ENTRY
Exterior shading device
Day lit atrium
COURTYARD
Area well for day lit basement
MAIN ENTRY
EMERGENCY ENTRY
Exterior shading device
Area well for day lit basement
1 Atrium
2 Admitting
3 Emergency
4 ICU
5 Women's Imaging
6 Diagnostic Imaging
7 Loading Dock
8 Shipping and Receiving
9 Resource Center
10 Gift Shop
11 Cafe
12 Pharmacy
13 Medical Records
14 Conference Center
15 Administration
16 Fitness Center
17 Physician Office

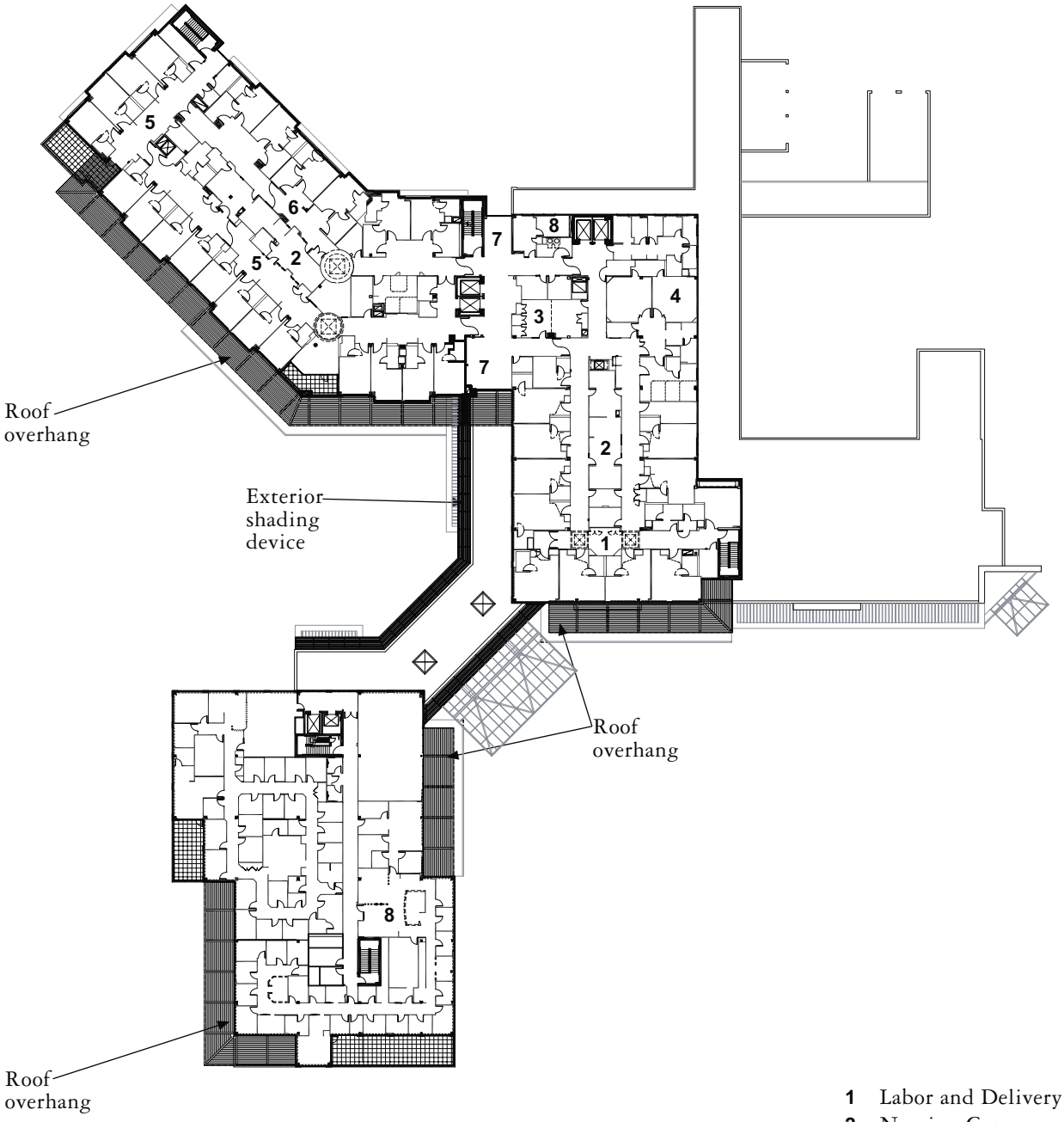
FIRST FLOOR



1 Atrium
2 Pre-Op
3 Surgery
4 Chapel
5 Med/Surg Beds
6 Nursing Core
7 Pediatrics
8 Waiting
9 Physician Office

SECOND FLOOR

North



1 Labor and Delivery
2 Nursing Core
3 Patient Education
4 C-Section Suite
5 Mother/Baby
6 Special Care Nursery
7 Waiting
8 Physician Office

North

THIRD FLOOR

Materials with Low-VOC's

Adhesives and Sealants
Paints and Coatings
Carpet
Composite Wood Products
- Casework
- Cornice Boards

Fire-treated Wood Blocking
Wood Doors

Materials Locally Harvested

Concrete
Gravel
Brick
Sandstone

Materials with Recycled Content

Concrete (flyash)
Steel and Rebar
Metal Studs
Exterior and Sound Insulation
Carpet
Acoustical Ceiling Tile
Casework
Wall guards
Task Chairs
Roller Shades

Rapidly Renewable Materials

Linoleum flooring
Cork/Linoleum tackboards

S U S T A I N A B I L I T Y


1


2


3


4


5


6

1 Cafe

2 Emergency Room

3 NICU Suite

4 Main Entrance

5 Entry into Pediatrics Wing

6 Mom/Baby Room